

REMARKS

Claims 1, 6, 7, 14, 17, 18, 20, 24, 26, 44, 61, 68 and 75-77 are pending in this application. Claims 1, 7, 11, 12, 14, 15, 17, 21, 25, 44, 61, 68, and 75-77 have been amended.

Claims 1, 6, 7, 9, 14, 17, 18, 20, 24, 26, 44, 61, 68, and 75-77 have been rejected under 35 U.S.C. §102(b) as being anticipated by Nishizawa et al., U.S. Patent No. 5,275,184.

The present invention relates to a method for reducing surface contaminants from the air/liquid interface in a wet etching bath. As such, amended independent claim 1 recites a "method for removing surface contaminants from an air/liquid interface" by "reducing a volume of a semiconductor processing fluid" in a processing bath by "rapidly displacing an upper portion of the semiconductor processing fluid" present in the bath "to remove said surface contaminants from said air/liquid interface." Similarly, amended independent claim 7 recites a method for "reducing the contamination on a semiconductor wafer" by "rapidly reducing a volume" of a wet etching bath by "removing a substantial portion of an upper portion of said etching fluid from said wet etching bath to remove surface contaminants from an air/liquid interface of said wet etching bath."

Amended independent claim 14 recites a method for "removing surface contaminants from an air/liquid interface of a semiconductor processing etching bath" by "reducing a volume of fluid in said semiconductor processing cleaning bath by rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath." This is accomplished by "rapidly removing a wafer boat containing said semiconductor wafer from said bath to remove said surface contaminants from said air/liquid interface." Amended independent claim 14 recites a method for "removing surface contaminants from an air/liquid interface of a semiconductor processing etching bath for processing semiconductor wafers." The method includes "reducing a volume of fluid in said semiconductor processing cleaning bath." This is accomplished by

"rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by rapidly removing a wafer boat containing said semiconductor wafer from said bath to remove said surface contaminants from said air/liquid interface."

Amended independent claim 17 recites a method for etching a semiconductor wafer with "an aqueous hydrofluoric acid" etching fluid, a volume of which is reduced by "rapidly removed a portion of said etching fluid from the upper surface of said wet etching vessel. Independent claim 61 recites a "method for removing surface contaminants from an air/liquid interface of a semiconductor processing bath" that includes "reducing a volume of said semiconductor processing bath" by "rapidly removing an upper portion of a semiconductor processing fluid present in said bath . . . to break eddy currents holding said surface contaminants at said air/liquid interface," while independent claim 68 recites "to break surface tension forces holding said surface contaminants at said air/liquid interface."

Independent claim 75 recites a "method for reducing the contamination on a semiconductor wafer" by "reducing a volume of etching fluid in said wet etching bath" and "breaking eddy currents of said wet etching bath by rapidly removing an upper portion of said etching fluid from said wet etching bath, said act of breaking said eddy currents further releasing surface contaminants which are formed at an air/liquid interface of said wet etching bath and held at said air/liquid interface by said eddy currents," while independent claim 76 recites "reducing a volume of said wet etching fluid" and "breaking surface tension forces of said wet etching bath by rapidly removing an upper portion of said etching fluid from said wet etching bath, said act of breaking said surface tension forces further releasing surface contaminants which are formed at an air/liquid interface of said wet etching bath and held at said air/liquid interface by said eddy currents."

Claim 77 recites a method for "reducing the contamination on a semiconductor wafer" which includes "processing said semiconductor wafer in a static etching bath

containing an etching fluid' and "reducing a volume of said etching fluid by rapidly removing an upper portion of said etching fluid while said semiconductor wafer is in said static etching bath."

Nishizawa et al. does not disclose any of the limitations of the claimed invention. Nishizawa et al. discloses an "apparatus for treating a wafer surface" (Col. 3, line 30) and "a system capable of rapidly substituting treatment solutions" (Col. 3, lines 19-20), but not a method for "reducing a volume" of processing fluid by "rapidly removing" an upper portion of the etching fluid containing "surface contaminants," as amended independent claims 1 and 7 recite. Nishizawa et al. also is silent about "reducing a volume of fluid in said semiconductor processing cleaning bath" by "rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by rapidly removing a wafer boat containing said semiconductor wafer from said bath to remove said surface contaminants from said air/liquid interface," as recited in amended claim 14. Nishizawa et al. similarly is silent about a method for etching a semiconductor wafer that includes reducing a volume of etching fluid by "rapidly removing a portion of said etching fluid from the upper surface of said wet etching vessel," as amended independent claim 17 recites. Amended independent claims 61, 68, 75, 76, and 77 similarly recite volume reduction of wafer treatment baths, and are not anticipated by Nishizawa et al. On the contrary, in Nishizawa et al., the volume of fluid in the bath remains constant as "old treatment solution inside the container is rapidly displaced by the new treatment solution" (col. 3, lines 54-55) so that the wafers do not "experience contact with air during replacement of the treatment solutions." (Abstract). The claims are respectfully submitted as being patentable over Nishizawa et al.

Claims 10, 27, 62 and 69 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Nishizawa et al. in view of Itoh et al., U.S. Patent No. 5,795,401.

The claimed invention would not have been obvious over Nishizawa et al. in view of Itoh et al. As noted above, Nishizawa et al. is silent about the reduction in volume of a treating bath, and also is silent regarding rapid removal of "surface contaminants" or of

“surface contaminants from an air/liquid interface” by opening a valve, hingedly releasing a door, sliding a door, or telescopically collapsing sidewalls of a vessel containing an etching bath. Itoh et al. recites using a “paddle,” (discussed further below) but does not teach or suggest reducing the volume of a treating bath, or removal of any contaminants from the etching bath, much less to the removal of “surface contaminants from an air/liquid interface.” Itoh et al. merely refers to the scrubbing of a wafer surface using a rotary brush while pressure is applied by jetting a fluid on the other surface of the wafer. In addition, Itoh et al. does not teach or suggest rapidly removing a substantial portion of the etching liquid. Itoh et al. does not even mention an etching fluid. Itoh et al. refers only to a wash liquid that is purified water and that comes into contact with a rotary brush that cleans the wafer surface. Thus, there is no teaching or suggestion in either of these two references for the claimed subject matter.

Further, Applicant respectfully submits that the proposed combination of references lacks the motivation required for a *prima facie* rejection under 35 U.S.C. § 103. Nishizawa et al. refers to wafer surface treatment by using at least two different solutions. Nowhere does Nishizawa et al. disclose or suggest reducing a volume of the treatment bath. Itoh et al. does not cure the deficiencies of Nishizawa et al., referring only to the actual physical cleaning and scrubbing of the wafer surface by mechanical means such as a cylindrical rotary brush. The back pressure “paddle” 7 disclosed by Itoh et al. is not analogous to the paddle recited in the claims of the present invention. On the contrary, paddle 7 disclosed by Itoh et al. is a fluid jet device that discharges an inert gas or high purity water as the back pressure fluid. Itoh et al. does not teach or suggest a paddle such as that disclosed and described in the present application which is utilized to reduce the volume of a treatment bath, as shown in Fig. 15, for example. Thus, the proposed combination appears to be based on picking and choosing selected portions of each reference, without regard to the totality of teachings of the references, in an improper attempt to reconstruct the invention using hindsight. Accordingly, a person of ordinary skills in the art could not have been motivated to combine Nishizawa et al. with Itoh et al., and withdrawal of this rejection is respectfully requested. Further, Applicants submit that

the proposed combination, even if properly combinable, fails to achieve the claimed invention. For example, the "paddle" disclosed in Itoh et al. will not reduce treatment bath volume as recited in the present claims. Claims 10, 27, 62, and 69 respectfully are submitted as being patentable over the cited Nishizawa et al. and Itoh et al. references.

Claims 11, 21, 63 and 70 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Nishizawa et al., in view of Mohindra et al., U.S. Patent No. 5,958,146.

The present invention as recited in amended independent claim 11 is a method for "removing surface contaminants from an air/liquid interface of a semiconductor processing etching bath for processing semiconductor wafers." The method includes "reducing a volume of said semiconductor processing bath" by "rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by opening a valve in said bath to remove said surface contaminants from said air/liquid interface." Independent claim 21 similarly recites "reducing a volume of said etching fluid."

As noted above, Nishizawa et al. does not teach or suggest removing surface contaminants by "reducing a volume of said semiconductor processing bath" by "rapidly removing an upper portion of a semiconductor processing fluid present in said bath." Further, Nishizawa et al. does not teach that the removal is accomplished by "opening a valve in said bath," as recited in the present invention.

Mohindra et al. does not cure the deficiencies of Nishizawa et al. Mohindra et al. discloses a cleaning technique for a semiconductor wafer that uses a hot or heated liquid in conjunction with a carrier gas which includes a cleaning enhancement substance. Mohindra discloses the use of control valves in the method of cleaning the semiconductor wafers, and the Office Action points out that "it would have been obvious to one ordinary skill in the art . . . to have provided Nishizawa et al. reference with a valve as taught by Mohindra et al. because the use of valve would have provided another method of removing

contaminants from the top of the wafer etching bath.” Although several control valves, and a drain valve 236, are disclosed, Mohindra et al. does not teach or suggest that any of the valves is used for the reducing volume of a treatment bath for rapid removal of “surface contaminants from an air/liquid interface” of an upper portion of the etching fluid, as in the claimed invention. Accordingly, there is nothing in the combination of Nishizawa et al. and Mohindra et al., without the improper use of hindsight reconstruction, to motivate a person of ordinary skills in the art to arrive at the claimed method. Claim 11 respectfully is submitted as being patentable over Nishizawa et al. and Mohindra et al. Claims 63 and 70 are dependent on independent claims 61, and 68, respectively, discussed previously.

Claims 12, 15, 22, 25, 64, 67, 71, and 74 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Nishizawa et al., in view of Hayami et al., U.S. Patent No. 5,474,616.

Nishizawa et al. lacks the requisite teaching of reducing a treatment fluid volume, as discussed above. Hayami et al. does not correct the deficiencies of Nishizawa et al. Hayami et al. teaches a method for rinsing plate-shaped articles, such as semiconductor wafers, as well as cleaning equipment for the rinsing method.

Prior to immersion, folding walls 20, are folded to release treating fluid. Hayami et al. does not teach or suggest removing a volume of treatment water “while said wafers are in said bath” as recited in the present claims.

Claims 12, 15, 22, 25, 64, 71, and 74 are submitted as being patentable over Nishizawa et al. and Hayami et al.

A marked-up version of the changes made to the claims by the current amendment is attached. The attached page is captioned “**Version with markings to show changes made.**”

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

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Version With Markings to Show Changes Made

1. (Amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing etching bath for processing semiconductor wafers, said method comprising:

immersing wafers in a bath of semiconductor processing fluid; and
reducing a volume of semiconductor processing fluid in said bath by rapidly
[removing] displacing an upper portion of a semiconductor processing fluid [present in]
from said bath while said wafers are immersed in said bath to remove said surface
contaminants from said air/liquid interface.

7. (Amended) A method for reducing the contamination on a semiconductor wafer from a wet etching bath comprising:

processing said semiconductor wafer in said wet etching bath containing an etching
fluid;

subsequently rapidly reducing a volume of said wet etching bath by removing a
substantial portion of an upper portion of said etching fluid from said wet etching bath to
remove surface contaminants from an air/liquid interface of said wet etching bath while
retaining said semiconductor wafer in said wet etching bath; and

subsequently removing said semiconductor wafer from said wet etching bath.

11. (Amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing etching bath for processing semiconductor wafers, said method comprising reducing a volume of said semiconductor processing bath by
rapidly removing an upper portion of a semiconductor processing fluid present in said bath,
while said wafers are in said bath, by opening a valve in said bath to remove said surface
contaminants from said air/liquid interface.

12. (Amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing cleaning bath for processing semiconductor wafers, said method comprising reducing a volume of fluid in said semiconductor processing cleaning bath by rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by hingedly releasing a door located at an upper portion of said bath to remove said surface contaminants from said air/liquid interface.

14. (Amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing etching bath for processing semiconductor wafers, said method comprising reducing a volume of fluid in said semiconductor processing cleaning bath by rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by rapidly removing a wafer boat containing said semiconductor wafer from said bath to remove said surface contaminants from said air/liquid interface.

15. (Amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing cleaning bath for processing semiconductor wafers, said method comprising reducing a volume of fluid in said semiconductor processing cleaning bath by rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by telescopically collapsing sidewalls of a vessel containing said bath to remove said surface contaminants from said air/liquid interface.

17. (Amended) A method for etching a semiconductor wafer, said method comprising:

placing an aqueous hydrofluoric acid etching fluid into a wet etching vessel;
[placing] immersing said semiconductor wafer in said etching fluid;
contacting said semiconductor wafer with said etching fluid for a predetermined time;

reducing a volume of said etching fluid in which said wafers are immersed by rapidly
removing a portion of said etching fluid from the upper surface of said wet etching vessel
while keeping said semiconductor wafer immersed in said etching fluid; and
removing said semiconductor wafer from said etching fluid.

21. (Amended) A method for etching a semiconductor wafer, said method comprising:

placing an etching fluid into a wet etching vessel;

placing said semiconductor wafer in said etching fluid;

contacting said semiconductor wafer with said etching fluid for a predetermined time; and

reducing a volume of said etching fluid by rapidly removing a portion of said etching fluid from the upper surface of said wet etching vessel by opening a valve in said wet etching vessel.

25. (Amended) A method for etching a semiconductor wafer, said method comprising:

placing an aqueous hydrofluoric acid solution into a wet etching vessel;

placing said semiconductor wafer in said aqueous hydrofluoric acid solution;

contacting said semiconductor wafer with said aqueous hydrofluoric acid solution for a predetermined time; and

reducing a fluid-containing volume of said wet etching vessel so as to rapidly
[removing] displace a portion of said aqueous hydrofluoric acid solution [etching fluid]

from the upper surface of said wet etching vessel by telescopically collapsing sidewalls of said wet etching vessel.

44. (Amended) A method for reducing the contaminants on a silicon wafer during a wet etching process, said method comprising:

immersing a wafer boat suspended on a lifting arm in an etching vessel having an aqueous hydrofluoric acid solution therein for a sufficient time to etch said silicon wafer; and

rapidly removing said wafer boat from said etching vessel to remove surface contaminants residing on the upper surface of said aqueous hydrofluoric acid solution by an upward movement of said arm, thereby causing said aqueous hydrofluoric acid solution to spill out of said vessel.

61. (Amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing bath for processing semiconductor wafers, said method comprising:

reducing a volume of said semiconductor processing bath by rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, to permit flow of said upper portion of said processing fluid and thereby break eddy currents holding said surface contaminants at said air/liquid interface.

68. (Amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing bath for processing semiconductor wafers, said method comprising:

reducing a volume of said semiconductor processing bath by rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, to permit flow of said upper portion of said processing fluid and thereby break surface tension forces holding said surface contaminants at said air/liquid interface.

75. (Amended) A method for reducing the contamination on a semiconductor wafer from a wet etching bath comprising:

processing said semiconductor wafer in said wet etching bath containing an etching fluid;

subsequently reducing a volume of etching fluid in said wet etching bath and breaking eddy currents of said wet etching bath by rapidly removing an upper portion of said etching fluid from said wet etching bath, said act of breaking said eddy currents further releasing surface contaminants which are formed at an air/liquid interface of said wet etching bath and held at said air/liquid interface by said eddy currents; and

subsequently removing said semiconductor wafer from said wet etching bath.

76. (Amended) A method for reducing the contamination on a semiconductor wafer from a wet etching bath comprising:

processing said semiconductor wafer in said wet etching bath containing an etching fluid;

subsequently reducing a volume of said wet etching fluid and breaking surface tension forces of said wet etching bath by rapidly removing an upper portion of said etching fluid from said wet etching bath, said act of breaking said surface tension forces further releasing surface contaminants which are formed at an air/liquid interface of said wet etching bath and held at said air/liquid interface by said eddy currents; and

subsequently removing said semiconductor wafer from said wet etching bath.

77. (Amended) A method for reducing the contamination on a semiconductor wafer, said method comprising:

processing said semiconductor wafer in a static etching bath containing an etching fluid; and

reducing a volume of said etching fluid by rapidly removing an upper portion of said etching fluid while said semiconductor wafer is in said static etching bath.